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Penny Plating Redox Lab

Earlier this month and year we talked about the oxidation numbers of different elements on the periodic table. In chemistry there is a process that takes place in some chemical reactions called Oxidation-Reduction or Redox Reactions. There are two parts to a Redox Reaction, the **reduction and the oxidation**. If a chemical or atom is ***reduced*** it ***GAINS*** electrons and becomes more negative, thus the reduction part. If a chemical or an atom becomes ***oxidized***, it ***LOOSES*** electrons. Now for the tricky part, an atom or ***compound that gives up electrons***, **becomes *oxidized***, is said to be ***reducing agent*** because it is causing another compound or element to become reduced. An atom or ***compound that gains electrons***, **becomes *reduced***, is said to be ***oxidizing agent*** because it is causing another compound or element to become oxidized.

In Redox reactions, sometimes ions just change their oxidation state in solution ($Fe^{3+}(aq) \rightarrow Fe^{2+}(aq)$), some change from an atom to an ion ($Cu(s) \rightarrow Cu^{2+}(aq)$), and some change from an ion to an atom ($Zn^{2+}(aq) \rightarrow Zn(s)$). When an ion changes to an atom there is a solution of dissolved ions that gets reduced (gains electrons) and will then settle on the agent that is getting oxidized. Remember, you can't have reduction without oxidation! Today we will reduce zinc and plate it onto a copper penny. (Or maybe we'll oxidize copper and dissolve it into a solution of zinc…)

Purpose:

To learn about Oxidation Reduction (redox) Reactions, change the color of pennies, have fun!

Materials: Per lab group

	(2) 150 mL Beakers	3.0 g Sodium chloride
	(1) 250 mL Beaker	15 mL 3.0 % Acetic Acid Solution
Tongs	(1) 50 mL Beaker for water	100 mL Graduated Cylinder
12 pennies	1.0 g Powdered Zinc	15 mL 3.0 M Sodium Hydroxide

Safety: NaOH is corrosive and pennies will become very hot

Procedure:

1. Read the procedure through first and make any data tables on a separate piece of paper.
2. Obtain at least 3 pennies per student group.
3. Wash the pennies by stirring them in a 150 mL beaker with 15.0 mL of vinegar mixed with 3.0 g of table salt. (This experiment won't work unless your pennies are sparkly clean!) Save the solution in this beaker to be used by the next class. Rinse pennies with water and dry with a paper towel – try not to touch with your hands as your oils interfere with the reaction.
4. Individually record the mass and any other observation about the **3** pennies you notice.
   Figure out a way to tell them apart first – date?
5. Weigh out 1.0 g powders Zinc. Take the Zn in your weigh paper back to your table and put into the 250 mL beaker.
6. Using your graduated cylinder pour in 15 mL of 3.0 M sodium hydroxide (NaOH). Then add to the 250 mL beaker. Swirl until zinc and NaOH mix.
7. Heat the 250 mL beaker **gently** on the Bunsen burner on medium flame until the mixture begins to bubble, and then turn down the burner to maintain a *very* slight boiling action. **Be sure to *replace lost water using DI water. It is very important to* maintain the same concentration of base! Do not let your solution actively boil or evaporate! It's very caustic!**
8. Using forceps put your pennies into the Zn/NaOH solution for about 5 minutes or until the pennies are silver.
9. Take pennies out of solution using the tongs and put them into a 150 mL beaker of rinse water.
10. Dry your penny and weigh it again. Record the new mass and any other observations in your data table.

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11. Using the tongs to hold the penny, quickly pass one side of the penny over the Bunsen burner flame until you observe a change. Repeat for the opposite side of the coin. Once you observe change on both sides of the coin, quench the penny in the rinse water beaker and then dry. Mass the coin and record your observations in your lab. Careful you **don't** "overcook" your coin.

Clean Up:

1. Place zinc/sodium hydroxide solution in the waste container in the fume hood.
2. Dump your rinse water down the drain.
3. Save your salt and vinegar solution for the next class.
4. Rinse out all equipment used and make sure your lab table looks the way it did when you came into class

Analysis:

1. A zinc solution was made from the zinc metal and the sodium hydroxide. Explain what happened to cause the penny to change color first to silver then to gold? You may need to do some research tonight on the internet to find the answer to this question. Is the silver coloring on the penny permanent? Could it rub off easily? Is the gold colored coating on the copper permanent? Could it rub off easily? Could this change have occurred with metals other than copper?

2. Compare the masses you measured for each of the three pennies. How do the masses compare after each reaction? If there was an increase in mass after the first change, it was probably zinc plating to the penny. The density of copper, zinc, silver, and gold are given below. Based upon this information and the data your group collected, **prove using mathematics** how you know that you really did not change the copper penny into gold. Explain your reasoning and show calculations. **How many moles of zinc were plated onto the penny?**

Metal	**Density in g/mL**
Copper	8.92
Zinc	7.14
Silver	10.5
Gold	19.5

3. Research on the internet and explain in a complete paragraph in your own words, what **you think** happened to the penny. How does this demonstrate a redox reaction? Make sure to include in your explanation what you think the purpose of each chemical was in the lab, (sodium hydroxide, zinc, copper) and the terms reduction, oxidation, oxidizing agent, and reducing agent. Which element gets oxidized? Which element gets reduced?

4. Read p. 677 in the textbook. In a complete paragraph explain how corrosion happens and how it can be prevented. Then explain why someone might want to electroplate a substance with a different metal (like what we just did). Galvanized nails are an example of this technology. Define the word "alloy". Do you think an alloy was produced in this lab? Explain.

5. **Extra Credit** What is the E° volt value for each half rxn from question #3. Use page 667 in your text to help.

A. Is the $E°_{cell}$ value positive or negative for the rxn between the penny and zinc?

B. What is the value of $E°_{cell}$ ($\mathbf{E°_{cell} = E°_{oxidation} + E°_{reduction}}$)